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Sustainment Key Performance Parameter and the RAM-C Manual

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This article addresses an increasing trend within the Department of Defense of systems not achieving the required reliability during developmental testing and subsequently being found unsuitable during Initial Operational Test and Evaluation. It introduces a Department systems engineering initiative to help requirements managers and program managers develop balanced and measurable sustainment requirements of reliability, availability, and maintainability (RAM) requirements with the development of a RAM-Cost Rationale Report Manual. This manual, in a coordination draft, will assist program managers and requirements managers to infuse robust systems engineering activities early in the program so that informed RAM trades are made throughout the life cycle. Thus better reliability will be designed into systems, validated through testing, and presumably resulting in systems that are more reliable and maintainable long term.

Key words: Maintenance; materiel availability; materiel reliability; mission requirements; ownership cost; sustainment requirements.

The Department of Defense spends billions of dollars acquiring, maintaining, and operating a wide variety of equipment. In doing so, the Department expects to acquire reliable and maintainable products that are of high quality, readily available, and able to satisfy user needs with measurable improvements to mission capability and operational support at a fair and reasonable price.

Not only is this equipment becoming more expensive to purchase, but the cost to operate, sustain, and maintain some new equipment is becoming much higher than anticipated or the equipment is not meeting the expected level of reliability, availability, and maintainability (RAM). Both of these ramifications have a negative impact on operational suitability and acceptable cost.

Sustainment requirements

In an effort to change this trend, the Department and subordinate Services are focusing more closely on sustainment requirements. In 2006, the Chairman of the Joint Chiefs of Staff defined three mandatory sustainment requirements to be articulated in requirements documents throughout a program's life cycle. These sustainment requirements include a Materiel Availability Key Performance Parameter (KPP) and two supporting Key System Attributes (KSA), Materiel Reliability and Ownership Cost. Although these are the three mandated sustainment requirements, maintainability and supportability analysis also underpin the systems engineering efforts that involve designing and developing these traits.

The Department understands that "sustainment" is a key component of performance and must be planned for during the first stages of concept refinement and system development, with the planning for all other mission capabilities. If these sustainment attributes are not adequately designed into the system, programs may breach Nunn-McCurdy thresholds[1], cost more than anticipated to own, or fail to achieve availability expected by the warfighter. Developing reasonable sustainment requirements will help ensure other mission performance requirements are achieved while balanced against the system life cycle cost for new and fielded systems.

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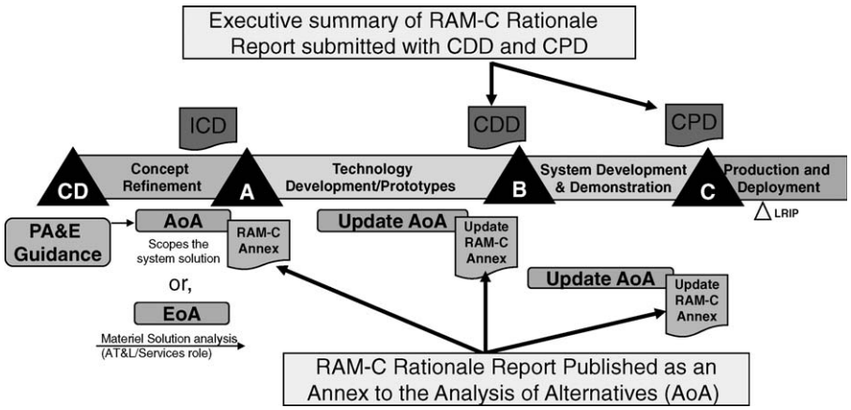

Figure 1. Expected timeline and associated documents with which the RAM-C Rationale Report will be submitted

The value of the sustainment KPP is derived from the operational requirements of the weapon system, assumptions for its operational use, and the planned logistical support to sustain it. In order for the program manager to develop a complete warfighting system with appropriate sustainment attributes, programs must establish both mission capability and sustainment requirements and measure the performance of the entire system against those requirements. The mandatory KPP and two supporting KSAs establishing that framework are summarized as follows:

- Materiel Availability KPP—Measures the percentage of the total inventory of a system that is operationally capable (ready for tasking) of performing an assigned mission, at a given time, based on materiel condition. Materiel availability also indicates the percentage of time that a system is operationally capable of performing an assigned mission and can be expressed as (end items ready for tasking)/(total end items procured).[2]
- Materiel Reliability KSA—Measures the probability that the system will perform without failure over a specified interval under specified conditions.
- Ownership Cost KSA—Provides balance to the sustainment solution by ensuring that the Operation and Support (O&S) costs associated with materiel readiness (e.g., maintenance, spares, fuel, support, etc.) are considered in making program decisions. The Ownership Cost KSA is ultimately based on O&S Cost Estimating Structure elements as specified in the OSD Cost Analysis Improvement Group (CAIG) "Operating and Support Cost-Estimating Guide."

RAM-C rationale report

To reinvigorate RAM systems engineering, the Department is developing a process, originally emphasized by the Army in the 1980s, requiring programs to develop a Reliability, Availability, Maintainability, and Cost (RAM-C) Rationale Report at the beginning of a program or during early concept development before it officially becomes a program.

The writers of requirements (the combat developers) and the program sponsors (or managers) must work together early to develop and understand mission and sustainment requirements that facilitate achieving the objective of affordable, suitable, and available systems. The logical process of developing sustainment requirements involves well-defined activities to arrive at values that are realistic, achievable, measurable, documented, and therefore defendable.

By documenting the rationale behind the development of the sustainment requirements with underlying assumptions, requirements writers and program managers will understand the basis for decisions made early in the program and will be better informed when trades need to be made later in the program.

The activities required to develop the RAM-C Rationale Report are detailed in a draft manual intended to be published in the October/November timeframe. Figure 1 shows the expected timeline and associated documents with which the RAM-C Rationale Report will be submitted.

The Service sponsor for concept refinement or system development of a new system will first document the sponsor's requirements rationale as early as the Analysis of Alternatives (AoA) during concept refinement. It is during this analysis that maintenance and supportability assumptions are first made and documented as part of the AoA. The Service sponsor conducting the AoA compares the various alternatives to determine the best potential materiel solution for the government, including how sustainment attributes and their sensitivities will be traded over the entire life cycle.

Once a materiel solution is selected, the combat developer will begin establishing the sustainment

1.1 Executive Summary
1.1.1 Summary of RAM Goals and Constraints
1.1.2 Description of Sustainment Requirement Element Values
1.1.3 Summary of Program Manager Analysis
1.1.4 Summary of Combat Developer Analysis including updated RAM-C Goals as appropriate
1.1.5 Summary of Sustainment System
1.1.6 Information for obtaining full RAM-C Report
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1.2 Program Summary Introduction
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1.4.1.2 A_M Rationale
1.4.1.3 Assumption Rationale
1.4.1.4 Relevant Facts Known
1.4.1.5 Supporting Analysis (Combat Developer and/or Program Manager)
1.4.2 Materiel Reliability
1.4.2.1 R_M Requirement
1.4.2.2 R_M Rationale
1.4.2.3 Assumption Rationale
1.4.2.4 Relevant Facts Known
1.4.2.5 Supporting Analysis (Combat Developer and/or Program Manager)
1.4.3 Ownership Cost
1.4.3.1 OC Requirement
1.4.3.2 OC Rationale
1.4.3.3 Assumption Rationale
1.4.3.4 Relevant Facts Known
1.4.3.5 Supporting Analysis (Combat Developer and/or Program Manager)

Figure 2. Outlines the suggested report format

requirements as part of the development of the Capability Development Document (CDD) and Capability Production Document (CPD). When the AoA is updated prior to each milestone decision, the RAM-C Rationale Report will be updated as well, to include validating or invalidating assumptions made earlier and to include an explanation of trades made as a result of lessons learned. This process, articulated in the manual, will require an executive summary of the RAM-C Rationale Report be attached to the CDDs and CPDs.

The draft manual will be a worthwhile tool for combat developers and program managers to use in developing their requirements and documenting their rationale. It provides a suggested Rationale Report format and walks through the steps to develop sustainment requirements and rationale using an example notional gun system. Figure 2 outlines the suggested report format.

The manual describes the process of developing and refining sustainment requirements. It begins with the combat developer using the Operational Mode Summary and Mission Profile (OMS/MP) along with the Failure Definition and Scoring Criteria (FD/SC) to conduct the analysis required to determine the maintenance and support concepts. This information is used to draft initial materiel availability, materiel reliability, and ownership cost goals. It is also used in supporting rationale and assumptions, including the levels of maintenance and the maintenance activities to be conducted at each level.

The program manager takes the above information and works with the combat developer to determine what is achievable based on technology maturity and other factors in order to make appropriate trades. Once the combat developer and program manager have reached agreement on a balanced solution with acceptable trades based on what is technologically possible, the combat developer needs to identify the appropriate sustainability requirements for inclusion in the CDD/CPD.

Requirements development

If done correctly, the combat developer will avoid writing requirements that include vague references to another system, such as "equal to or greater than predecessor system" or "50% less to support than the predecessor system." Such references make the requirements difficult to measure because the predecessor system requirements are often unknown or may not be compatible with the new system. In addition, such phrasing leads to side-by-side comparative testing that may be both costly and unrealistic and may not provide the results that effectively illustrate the system's ability to succeed in the field. The combat developer should write requirements that fit the operational needs foreseen while also including probability values required. For example, "the system must have a 95% chance of completing a 12-hour mission without a mission-affecting failure" or "the system should have a maximum mean time to repair of 4 hours for up to the 95th percentile repair."

The requirements development process concludes when all inputs are translated into materiel availability, materiel reliability, and ownership cost with supporting rationale so that the program manager can develop a plan to design-in and achieve the threshold values within established cost and schedule parameters. It is expected that the program managers will then contract for the appropriate activities to design-in and evaluate RAM to ensure threshold values are demonstrated in

developmental test and evaluation prior to the initial operational test and evaluation. It is vital that these plans to develop, design, and measure these RAM requirements are included in the Request for Proposal and subsequent contracts.

Conclusion

In the end, the sustainment requirements must enable warfighter functional requirements and must be measurable and obtainable. All program activities must carefully balance technological feasibility with operational needs and desires. Program requirements are subject to trade-off in order to optimize all requirements, including sustainment requirements.

The manual is currently in draft and has been informally staffed within the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, the Director of Operational Test and Evaluation, the Joint Staff, and a few outside agencies. We expect the manual to be published and implemented in FY 2009. ❑

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Endnotes

[1]Programs may breach Nunn-McCurdy thresholds with significantly higher than projected Program Acquisition Unit Cost or Average Procurement Unit Cost in the Acquisition Program Baseline due to resulting corrective action costs.

[2]Discussion of the Materiel Availability (A_M) KPP must begin with the differences in purpose between A_M and the more well known Operational Availability (A_O) metric. The purpose of A_O is to provide a measure of a single end item readiness for use when intended. As such, the uptime and downtime calculations for A_O are related to restoring individual end items to use after a maintenance action is performed. Conversely, A_M applies to the entire inventory of a given end item and covers not only those end items in operational use but also those in a temporary non-operational state. For the A_M metric, items in a temporary non-operational state (at depot for overhaul/upgrade, held in reserve as spares, not assigned to an operational unit, etc.) are recorded as being "down" (i.e. unavailable for operational use). For the A_O metric, most temporary non-operational states are not considered as either "up" or "down" times.